IN THE UNITED STATES PATENT AND TRADEMARK OFFICE BEFORE THE HONORABLE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of M. CHILDS	)	Examiner: J. Zhu
	)	Art Unit: 2831
Serial No.: 10/541,007	)	
	)	Confirmation: 8600
Filed: June 28, 2005	)	
For: **IMAGE SENSOR**	)	
Date of Last Office Action: June 3, 2008	)	
Attorney Docket No.: GB030001US PKRX 2 00095	)	Cleveland, OH 44114 November 19, 2008

BRIEF ON APPEAL

This is an appeal from the final rejection of June 3, 2008 rejecting claims 1-20 (all claims). For the reasons set forth below, a reversal of these rejections is requested.

I. STATEMENT OF REAL PARTY IN INTEREST (41.37(f))

The real party in interest for this appeal and the present application is KONINKLIJKE PHILIPS.

II. STATEMENT OF RELATED CASES (41.37(g))

There are no prior or pending appeals, interferences or judicial proceedings, known to Appellant, Appellant's representative, or the Assignee, that may be related to, or which will directly affect or be directly affected by or have a bearing upon the Board's decision in the pending appeal.

III. JURISDICTIONAL STATEMENT (41.37(h))

The Board has jurisdiction under 35 U.S.C. 134(a).

The Examiner mailed the final rejection, from which this appeal is taken, on June 3, 2008, setting a three-month shortened statutory period for response. The time for responding to the final rejection expired on September 3, 2008. Rule 134.

A notice of appeal and a request for a one-month extension of time under Rule 136(a) was filed on September 25, 2008. The time for filing an appeal brief is two months after the filing of a notice of appeal. Bd.R. 41.37(c).

The time for filing an appeal brief expires on November 25, 2008. The appeal brief is being filed on the date shown on Certificate of Transmission.

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V. TABLE OF AUTHORITIES (41.37(j))

VI. STATUS OF AMENDMENTS (41.37(l))

Amendment D of August 7, 2008 was entered by the Examiner.

VII. GROUNDS OF REJECTION TO BE REVIEWED (41.37(m))

Whether claims 2, 10, 13-16, and 19 are patentable in the sense of 35 U.S.C. § 103 over Busse (US 6,653,636) as modified by Abdalla ("Nuclear Instruments and Methods in Physics Research" article).

Whether claims 3-9, 17, and 18 are patentable in the sense of 35 U.S.C. § 103 over Busse as modified by Abdalla as further modified by Kozlowski (US 6,417,508).

Whether claims 11, 12, and 20 are patentable in the sense of 35 U.S.C. § 103 over Busse as modified by Abdalla as further modified by Marshall (US 6,858,912).

VIII. STATEMENT OF FACTS (41.37(n))

1. It is an object of Busse to provide a sensor and a method of operating the sensor wherein a high stability of the transfer function and an attractive signal-to-noise ratio are ensured by a comparatively simple and economical construction (Busse, col. 2, l. 31-35).

2. Busse's proposed solution has a particularly advantageous aspect which is formed by the stability of the transfer function of the circuit. (Busse, col. 9, l. 8-13).

3. The Busse gain stability of the circuit is due to the fact that the source follower transistor 21 has a stable voltage amplification amounting to 1 which is converted into a charge amplification $G_Q = C_S/C_P$ by means of the sampling capacitor 26. (Busse, col. 9, l. 8-23).

4. This object of Busse is achieved by means of a sensor which is characterized in that the means for amplifying include a respective source follower transistor whose gate is connected to the conversion element, whose source is connected an active load and to one side of a sampling capacitor, the other side of the sampling capacitor being connected to the read-out line via the read-out switching element, and that a respective reset element is connected to the conversion element in order to reset the conversion element to an initial state. (Busse, col. 3, l. 38-47).

5. The aim of Busse is to realize sensors having as high a possible a signal-to-noise ratio. (Busse, col. 1, l. 59-60).

6. When signal amplification of an amplifier fluctuates in time, offset and gain artifacts occur. (Busse, col. 1, l. 16-19).

7. Such fluctuations may be caused by changes in temperature or other operating conditions, aging, radiation damage, or trapping effects (Busse, col. 2, l. 12-24).

8. The Busse source follower transistors have a stable voltage amplification of 1 (Busse, col. 2, l. 56-57; col. 6, l. 51-52).

9. Busse is concerned with stability of the transfer function, particularly Gain stability and offset stability (Busse, col. 10, l. 29-34).

10. Amplification G_Q of Busse is achieved by the ratio of the storage capacitor C_S (26) to that of the storage capacitor C_P (2). (Busse, col. 2, l. 58; col. 8, l. 59-62).

11. One problem with the charge amplification approach is that the area required for the sampling capacitor is large and can limit the resolution which can be achieved (present application, pg. 2, l. 8-11).

12. A small sampling capacitor enables its size to be kept small so that the pixel circuitry occupies the smallest possible space, thereby enabling large aperture pixels to be formed (present application, pg. 2, l. 20-22).

13. Abdalla is directed to a CMOS active pixel sensor (APS) circuit (Abstract).

14. The Abdalla circuit operates in a different principle from Busse (Abdalla, p. 233, sec. 2 "Pixel Design").

15. An aim of Abdalla is to evaluate the performance of CMOS APS technology as a possible replacement for the currently dominating high cost CCD systems (Abdalla, p. 233, col. 1, l. 29-32).

16. Kowalski discloses capacitors in the femtofarad range (Kowalski, col. 3, l. 31, 35, 44, and 15; col. 5, l. 8; col. 6, l. 8).

17. In Kowalski, the discussed capacitors have a ratio on the order of 1:5 to 1:125 (col. 5, l. 8; col. 6, l. 8).

18. In the present application, a voltage amplifier has a gain greater than 1 (p. 2, l. 17; p. 3, l. 23 and 24), preferably in the range of 2:5 (p. 3, l. 4).

19. In the present application, the voltage V is provided by the photodiode is amplified by an in-pixel amplifier 16 with gain G, so that a sampling capacitor 18 at the output of the amplifier is charged to a greater voltage than the photodiode voltage. (present application, p. 5, l. 3-5).

20. As a result, a greater flow of charge is required and the charge flow is measured as the output of the pixel (present application, p. 5, l. 5-9).

21. The circuit design of the present application enables the size of the sampling capacitor to be reduced, so that the pixel circuit components can occupy a smaller space, thereby improving the optical aperture of the pixel (p. 5, l. 14-16).

22. Busse does not explicitly disclose a voltage amplifier having a gain greater than 1 between the pixel storage capacitor and the sampling capacitor (June 3, 2008 Office Action, p. 2, last 2 lines).

23. The Examiner asserts that it would be obvious to modify Busse to include the push-pull amplifier system of Abdalla (September 2008 Office Action, p. 3, second paragraph).

24. The Appellant asserted that unity gain is a necessary element of Busse (Amendment D, pp. 8-10).

25. In the present application, the size of the sampling capacitor can be kept to a minimum (present application, p. 2, l. 30).

26. The arrangement of the present application enables the sampling capacitor to be kept to a low size, so that the pixel circuitry occupies the smallest possible space, thereby enabling large aperture pixels to be formed (present application, p. 2, l. 20-22).

27. Abdalla calls for a push-pull amplifier with a gain of 30 (Abdalla, p. 233, col. 2, l. 4).

28. Abdalla discloses a circuit that is and functions differently than the circuit disclosed in Busse (Abdalla, Figure 1 and p. 233, section 2 Pixel Designs).

29. The Examiner asserts that Kozlowski discloses a sampling capacitor approximately equal to a pixel storage capacitor (September 2008 Office Action, p. 4, last paragraph).

IX. ARGUMENT (41.37(o))

A. Claim 1 Distinguishes Patentably Over the References of Record

In the Office Action of June 3, 2008 at page 2, paragraph 3, the Examiner sets forth the elements of claim 1 which he asserts are shown by Busse and specifically concedes that Busse does not explicitly disclose a voltage amplifier having a gain greater than 1 between the pixel storage capacitor and the sampling capacitor. The Examiner asserts that Abdalla discloses a push/pull amplifier system with a gain greater than 1. The Examiner reaches the unwarranted conclusion that it would be obvious to modify Busse to provide an amplifier with a gain greater than 1. However, the Examiner provides no analysis or reasoning for reaching this unwarranted conclusion. (September 2008 Office Action, para. 3).

In Amendment D of August 7, 2008, pages 8-10, the Appellant pointed out that a buffer 21, 23 with a unity gain is a required element of Busse.

More specifically (with re-editing for greater clarity and forcefulness), Busse relies on charge amplification resulting from the ratio of the size of the sampling capacitor C_S 26 to the storage capacitor C_P 2. (col. 2, l. 56-60). Busse needs a large sampling capacitor 26 in order to achieve the desired gain G_Q. (col. 9, pp. 8-24). One problem in Busse is that the relatively large sampling capacitor requires a relatively large amount of real estate, which inhibits high resolution (small, closely packed) pickup devices.

By contrast, instant claim 1 calls for providing voltage gain through voltage amplification. This enables, for example, the sampling capacitor to be small in size such that the pixel circuitry occupies the smallest possible space, thereby enabling large aperture pixels to be formed, i.e., pixels with a large light sensitive area within a small light insensitive border.

Moreover, Busse argues against replacing the unity gain amplifier 21, 23 with an amplifier with a higher gain. Specifically, Busse describes the charge amplification as follows:

> The proposed solution has a particularly advantageous aspect which is formed by the stability of the transfer function of the circuit. This gain stability of the circuit is due to the fact that the source follower transistor 21 has a stable voltage amplification amounting to 1 which is converted into a charge amplification $G_Q = C_S/C_P$ by means of the sampling capacitor. (Busse, col. 9, l. 8-23).
>
> Busse explains how he achieves his objective of providing a sensor and a method of operating the sensor wherein a high stability of the transfer function and an attractive signal-to-noise ratio are ensured by a comparatively simple and economical construction, specifically:

The proposed solution has a particularly advantageous aspect which is formed by the stability of the transfer function of the circuit. <u>This gain stability of the circuit is due to the fact that the source follower transistor 21 has a stable voltage amplification amounting to 1 which is converted into a charge amplification $G_Q = C_S/C_P$ by means of the sampling capacitor 26</u>. (Busse col. 9, l. 8-23)(emphasis added).

This object is achieved by means of a sensor which is characterized in that the means for amplifying include a respective source follower transistor whose gate is connected to the conversion element, whose source is connected an active load and to one side of a sampling capacitor, the other side of the sampling capacitor being connected to the read-out line via the read-out switching element, and that a respective reset element is connected to the conversion element in order to reset the conversion element to an initial state. (Busse, col. 2, l. 38-47).

To modify Busse as suggested by the Examiner would obviate or destroy this objective of Busse, because Busse specifically teaches against the use of a voltage amplifier 16 having a gain greater than 1.

It is unimaginable how one having knowledge of Busse and its objective of gain stability specifically due to a stable **unity** voltage amplification would find it obvious to provide a voltage gain greater than unity through voltage amplification. Using a voltage gain greater than unity, as proposed by the Examiner, would destroy the objective of Busse, particularly the stability of the transfer function which stability results from the voltage amplification being unity. The Examiner has not explained what would motivate such a destruction of the Busse objective, other than his own hindsight. More importantly, since Busse does not disclose voltage amplification greater than unity, the Examiner is effectively suggesting that the invention of Busse should be modified, but modified in a way that is directly contrary to the fair teachings of Busse. According to Busse, increasing the amplification, particularly by a large factor such as the factor of 30 as suggested by Abdalla, would destroy the gain stability of the circuit because the gain stability of the circuit results from a stable, unity voltage amplification. As a result of the Examiner's proposed modification, the Busse invention would be destroyed.

It is well settled that a 35 U.S.C § 103 rejection based on a modification of a reference that destroys the intent, purpose, or function of the invention disclosed in the reference does not make a proper or prima facie case of

obviousness. In short, there is no technological motivation for modifying or changing Busse as the Examiner suggests. To the contrary, Busse discloses disincentives to such modification. See In re Gordon, 733 Fed.2d, 900 (Fed.Cir. 1984). Accordingly, it is submitted that the Examiner has failed to establish a prima facie case of obviousness.

(New) Abdalla discloses a different circuit from Busse which does not rely on a charge ratio between a sampling capacitance C_S and a storage capacitance C_P. Indeed, the Abdalla circuit does not show a capacitance which is the equivalent of the required storage capacitance C_S (26) of Busse. Thus, although Abdalla does show amplifiers with a gain greater than 1 are known, Abdalla shows an amplifier in a different circuit which functions in a materially different way than Busse. The Examiner has failed to point out anywhere in Abdalla, where Abdalla would suggest or cause others to believe that or why it would be advantageous to increase the amplification in Busse above the unity amplification that provides the stability which is the objective of the Busse patent.

Accordingly, it is submitted that claim 1 and claims 2-5, 7-13, and 20 dependent therefrom, and claim 6, and claim 14 along with claims 15-17 and 19 dependent therefrom distinguish patentably and unobviously over the references of record.

B. Claim 5 Distinguishes Patentably Over the References of Record

Claim 5 calls for the sampling capacitor to be approximately equal to the capacitance of the pixel storage capacitor. In paragraph 4 on page 4 of the Office Action, the Examiner asserts that this limitation is rendered obvious by Kozlowski.

First, because Busse relies on charge amplification and the ratio of C_S/C_P, having these capacitances approximately equal would set the gain G_Q of Busse to 1.

Moreover, as pointed out on page 10 of Amendment D, leaving aside the issue of whether it is obvious to modify Busse by Kozlowski, Kozlowski calls for the ratio of his clamping capacitor to his detector capacitor to be in the range of 1:5 to 1:125. Thus, Kozlowski and Busse both teach that capacitances such be different by a factor of at least 5, not approximately equal as called for by claim 5.

Accordingly, it is submitted that claim 5 distinguishes patentably and unobviously over the references of record.

C. Claim 6 Distinguishes Patentably Over the References of Record

The Examiner addresses his reasons for rejecting claim 6 in paragraph 4 on page 4 of the Office Action of June 3, 2008 and in the continuation page of the Advisory Action of September 10, 2008.

On page 10 of Amendment D, the Appellant has pointed out that the Examiner has failed to recognize that the capacitances called for in claim 5 are in picofarads (pF); whereas, the capacitance values referenced in Kozlowski are femtofarads (fF). Because there are orders of magnitudes of difference of picofarads and femtofarads, the Appellant asserts that Kozlowski does not disclose that which the Examiner alleges.

Accordingly, it is submitted that claim 6 distinguishes patentably and unobviously over the references of record.

D. Claim 9 Distinguishes Patentably Over the References of Record

Claim 9 calls for the sampling capacitor to be in the range of 0.5 pF - 3 pF and the self capacitance of the light sensor to be in the range of 0.5 pF - 3 pF. The Examiner addresses claim 9 in paragraph 4 on page 4 of the Office Action of June 3, 2008 and the Advisory Action of September 10, 2008. On page 11 of Amendment D, the Appellants reiterated that because Kozlowski's capacitance values are in femtofarads; whereas, claim 9 calls for picofarads, Kozlowski does not disclose that which the Examiner asserts.

E. Claim 10 Distinguishes Patentably Over the References of Record

Claim 10 calls for the gain of the voltage amplifier to be in the range of 2 - 5. The Examiner addresses claim 10 in paragraph 3 on page 2 of the final

rejection which alleges that amplification in the range of 2 -5 is rendered obvious by Abdalla. In Amendment D on page 11, the Appellant pointed out that Abdalla discloses a gain of 30. Accordingly, Abdalla does not disclose or fairly suggest a gain in the range of 2-5 as the Examiner suggests. Moreover, as stated above, unity gain is an essential feature of Busse which Busse specifically teaches against increasing.

F. Claim 19 Distinguishes Patentably Over the References of Record

Claims 19 calls for the gain of the voltage amplifier to be in the range of 2-5. The Examiner addresses claim 19 in paragraph 3 on page 2 of the final rejection. The Examiner asserts that the gain is not a fixed gain for all pixel preamplifiers as different systems require different gains with corresponding optical sensitivity. The Examiner provides no basis for this assertion and alludes to no support for this assertion in either of the applied references.

The Appellant addresses claim 19 on page 11 of Amendment D. Again, Busse calls for unity amplification for stability and Abdalla calls for no charge amplification and an amplifier gain of 30. As stated above, changing the unity gain of Busse would destroy the stability objective of Busse. Moreover, neither reference provides motivation for amplification in the range of 2-5.

Accordingly, it is submitted that claim 19 distinguishes patentably over the references of record.

G. Claim 20 Distinguishes Patentably Over the References of Record

Claim 20 calls for the second transistor (40) to have a non-unity voltage amplification. The Examiner addresses claim 20 in paragraph 5 on page 5 of the final rejection. The Examiner notes that Marshall in Figure 5 discloses transistors MA52 and MA51 in a push/pull relationship with a non-unity gain.

(New) Because these transistors are positioned substantially the same as transistors M5 and M6 in Abdalla, it is unclear what Marshall adds to the combination of Busse and Abdalla discussed above. Again, the objective of Busse is stability, which stability depends on the unity gain amplifier. Neither Abdalla with its gain of 30 nor Marshall with its "high gain" (Marshall, col. 8, l. 67) would teach a third party to increase the unity gain of Busse at the cost of Busse's stability objective.

Accordingly, it is submitted that claim 20 distinguishes patentably and unobviously over the references of record.

CONCLUSION

For all of the reasons set forth above and in the arguments in the Appellant's prior amendments, it is respectfully submitted that claims 1-20 distinguish patentably un unobviously over the references of record. An early reversal of the Examiner's rejections is requested.

Respectfully submitted,

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APPENDIX

X. CLAIMS ON APPEAL (41.37(p))

1. (Rejected) An image sensor comprising a plurality of pixels, each pixel comprising: a light sensor element (12), a sensor voltage across the element varying depending on the light incident on the element (12); a voltage amplifier (16) having gain greater than 1; and a sampling capacitor (18) charged by the voltage amplifier.

2. (Rejected) An image sensor as claimed in claim 1, wherein each pixel further comprises a pixel storage capacitor (14) connected to the light sensor element (12) and wherein the voltage gain between the pixel storage capacitor and the sampling capacitor is greater than one.

3. (Rejected) An image sensor as claimed in claim 2, wherein the capacitance of the sampling capacitor (18) is less than 10 times the capacitance of the pixel storage capacitor (14).

4. (Rejected) An image sensor as claimed in claim 3, wherein the capacitance of the sampling capacitor (18) is less than 2 times the capacitance of the pixel storage capacitor (14).

5. (Rejected) An image sensor as claimed in claim 4, wherein the capacitance of the sampling capacitor (18) is approximately equal to the capacitance of the pixel storage capacitor (14).

6. (Rejected) An image sensor comprising a plurality of pixels, each pixel comprising:

a light sensor element (12), a sensor voltage across the element ~~varying depending on light incident on the element (12);~~

a pixel storage capacitor (14) connected to the light sensor element (12);

a voltage amplifier (16) having a gain greater than 1; and

a sampling capacitor (18) charged by the voltage amplifier,

wherein a voltage gain between the pixel storage capacitor and the sampling capacitor is greater than one,

wherein the capacitance of the sampling capacitor (18) is less than 10 times the capacitance of the pixel storage capacitor (14), and

wherein the capacitance of the sampling capacitor (18) is in the range 0.5 pF to 3 pF, and the capacitance of the pixel storage capacitor (14) is in the range 0.5 pF to 3 pF.

7. (Rejected) An image sensor as claimed in claim 1, wherein the capacitance of the sampling capacitor (18) is less than 10 times a self-capacitance of the light sensor element (12).

8. (Rejected) An image sensor as claimed in claim 7, wherein the capacitance of the sampling capacitor (18) is less than 2 times the self-capacitance of the light sensor element (12).

9. (Rejected) An image sensor as claimed in claim 7, wherein the capacitance of the sampling capacitor (18) is in the range 0.5 pF to 3 pF, and the self-capacitance of light sensor (12) is in the range 0.5 pF to 3 pF.

10. (Rejected) An image sensor as claimed in claim 1, wherein the gain of the voltage amplifier (16) is in the range 2 to 5.

11. (Rejected) An image sensor as claimed in a claim 1, wherein the voltage amplifier (16) comprises first (38) and second (40) transistors in series between power lines (15), the light sensor element (12) being connected to the gate of one of the transistors (40), and a bias voltage (44) being connected to the gate of the other transistor (38), the output of the voltage amplifier (16) being defined at the connection between the first and second transistors (38, 40).

12. (Rejected) An image sensor as claimed in claim 11, wherein the output of the voltage amplifier (16) is connected to one terminal of the sampling capacitor (18), the other terminal of the sampling capacitor (18) being connected to the pixel output through an output switch (22; 34).

13. (Rejected) An image sensor as claimed in claim 1 wherein each pixel further comprises an input switch (20; 30) for applying a fixed potential (Vreset) across the light sensor element.

14. (Rejected) A method of measuring light intensity of an image to be detected using a plurality of light sensor elements (12) each forming a pixel of an image sensor, a sensor voltage (Vin) across the elements varying depending on the light incident on the elements, the method comprising: amplifying the sensor voltage (Vin) using an in-pixel voltage amplifier (16) having a gain greater than 1; charging a sampling capacitor (18) with the amplified voltage (Vout) and measuring the flow of charge required to charge the sampling capacitor (18).

15. (Rejected) A method as claimed in claim 14, wherein a reset operation is carried out before amplifying the sensor voltage (Vin), the reset operation comprising applying a known potential to one terminal of the

sampling capacitor (18) and applying a known potential (Vreset) across the sensor element, the amplified voltage (Vout) being subsequently applied to the other terminal of the sampling capacitor (18).

16. (Rejected) A method as claimed in claim 14, wherein the voltage gain between a pixel storage capacitor and the sampling capacitor is greater than one.

17. (Rejected) A method as claimed in claim 16, wherein the capacitance of the sampling capacitor (18) is less than 2 times the capacitance of the pixel storage capacitor (14).

18. (Rejected) A method as claimed in claim 17, wherein the capacitance of the sampling capacitor (18) is approximately equal to the capacitance of the pixel storage capacitor (14).

19. (Rejected) A method as claimed in claim 14, wherein the gain of the voltage amplifier (16) is in the range 2 to 5.

20. (Rejected) An image sensor as claimed in claim 11, wherein the second (40) transistor has a non-unity voltage amplification.

APPENDIX (Continued)

XI. CLAIM SUPPORT AND DRAWING ANALYSIS SECTION (41.37(r))

1. An image sensor comprising a plurality of pixels, each pixel comprising: a light sensor element (12) {**p4,l22-23**}, a sensor voltage across the element varying depending on the light incident on the element (12) {**p4,l29-32**}; a voltage amplifier (16) having gain greater than 1 {**p7,l1**}; and a sampling capacitor (18) charged by the voltage amplifier {**p5,l5-9**}.

2. An image sensor as claimed in claim 1, wherein each pixel further comprises a pixel storage capacitor (14) {**p5,l1-4**} connected to the light sensor element (12) {**p4,l24-32**} and wherein the voltage gain between the pixel storage capacitor and the sampling capacitor is greater than one {**p7,l1**}.

3. An image sensor as claimed in claim 2, wherein the capacitance of the sampling capacitor (18) is less than 10 times the capacitance of the pixel storage capacitor (14) {**p2,l26-29**}.

4. An image sensor as claimed in claim 3, wherein the capacitance of the sampling capacitor (18) is less than 2 times the capacitance of the pixel storage capacitor (14) {**p2,l27**}.

5. An image sensor as claimed in claim 4, wherein the capacitance of the sampling capacitor (18) is approximately equal to the capacitance of the pixel storage capacitor (14) {**p2,l28-29; p5,l10-11**}.

6. An image sensor comprising a plurality of pixels, each pixel comprising:

a light sensor element (12) {**p4,l21-23**}, a sensor voltage across the element varying depending on light incident on the element (12) {**p4,l29-32**};

a pixel storage capacitor (14) connected to the light sensor element (12) {**p4,l24-32**};

a voltage amplifier (16) having a gain greater than 1 {**p2,l17; p7,l1**}; and

a sampling capacitor (18) charged by the voltage amplifier {**p5,l5-09**},

wherein a voltage gain between the pixel storage capacitor and the sampling capacitor is greater than one {**p9,l1**},

wherein the capacitance of the sampling capacitor (18) is less than 10 times the capacitance of the pixel storage capacitor (14) {**p2,l26-27**}, and

wherein the capacitance of the sampling capacitor (18) is in the range 0.5 pF to 3 pF, and the capacitance of the pixel storage capacitor (14) is in the range 0.5 pF to 3 pF {**p3,l1-3**}.

7. An image sensor as claimed in claim 1, wherein the capacitance of the sampling capacitor (18) is less than 10 times a self-capacitance of the light sensor element (12) **{p2,l26-27; p4,l31-32}**.

8. An image sensor as claimed in claim 7, wherein the capacitance of the sampling capacitor (18) is less than 2 times the self-capacitance of the light sensor element (12) **{p2,l27; p4,l31-32}**.

9. An image sensor as claimed in claim 7, wherein the capacitance of the sampling capacitor (18) is in the range 0.5 pF to 3 pF, and the self-capacitance of light sensor (12) is in the range 0.5 pF to 3 pF **{p3,l1-3 p4; l31-32}**.

10. An image sensor as claimed in claim 1, wherein the gain of the voltage amplifier (16) is in the range 2 to 5 **{p3,l3-4}**.

11. An image sensor as claimed in a claim 1, wherein the voltage amplifier (16) comprises first (38) and second (40) transistors in series between power lines (15) **{p6,l15-17}**, the light sensor element (12) being connected to the gate of one of the transistors (40) **{p7; p18-19}**, and a bias voltage (44) being connected to the gate of the other transistor (38) **{p7,l19-20}**, the output of the voltage amplifier (16) being defined at the connection between the first and second transistors (38, 40) **{p7,l20-21}**.

12. An image sensor as claimed in claim 11, wherein the output of the voltage amplifier (16) is connected to one terminal of the sampling capacitor (18) {**p5,l5-6**}, the other terminal of the sampling capacitor (18) being connected to the pixel output through an output switch (22; 34) {**p5,l25-27**}.

13. An image sensor as claimed in claim 1 wherein each pixel further comprises an input switch (20; 30) for applying a fixed potential (Vreset) across the light sensor element {**p5,l17-18**}.

14. A method of measuring light intensity of an image to be detected using a plurality of light sensor elements (12) each forming a pixel of an image sensor {**p3,l19-21**}, a sensor voltage (Vin) across the elements varying depending on the light incident on the elements {**p3,l21-22**}, the method comprising: amplifying the sensor voltage (Vin) using an in-pixel voltage amplifier (16) having a gain greater than 1 {**p3,l23-24**}; charging a sampling capacitor (18) with the amplified voltage (Vout) and measuring the flow of charge required to charge the sampling capacitor (18) {**p3,l25-26**}.

15. A method as claimed in claim 14, wherein a reset operation is carried out before amplifying the sensor voltage (Vin) {**p3,l27-28**}, the reset operation comprising applying a known potential to one terminal of the sampling capacitor (18) and applying a known potential (Vreset) across the

sensor element **{p3,l28-30}**, the amplified voltage (Vout) being subsequently applied to the other terminal of the sampling capacitor (18) **{p3,l30-31}**.

16. A method as claimed in claim 14, wherein the voltage gain between a pixel storage capacitor and the sampling capacitor is greater than one **{p3,l23-24}**.

17. A method as claimed in claim 16, wherein the capacitance of the sampling capacitor (18) is less than 2 times the capacitance of the pixel storage capacitor (14) **{p2,l26-27}**.

18. A method as claimed in claim 17, wherein the capacitance of the sampling capacitor (18) is approximately equal to the capacitance of the pixel storage capacitor (14) **{p2,l28-29; p5,l10-11}**.

19. A method as claimed in claim 14, wherein the gain of the voltage amplifier (16) is in the range 2 to 5 **{p3,l3-4}**.

20. An image sensor as claimed in claim 11, wherein the second (40) transistor has a non-unity voltage amplification **{p2,l5-11; p6,l27-31}**.

APPENDIX (Continued)

XII. MEANS OR STEP PLUS FUNCTION ANALYSIS SECTION (41.37(s))

Not applicable.

APPENDIX (Continued)

XIII. EVIDENCE SECTION (41.37(t))

Not applicable.

APPENDIX (Continued)

XIV. RELATED CASES SECTION (41.37(u))

Not applicable.